

Trends ⁱⁿ Ecology & Evolution

What to do when endangered
species recover

CellPress

Lifting baselines to address the consequences of conservation success

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Biologists and policymakers are accustomed to managing species in decline, but for the first time in generations they are also encountering recovering populations of ocean predators. Many citizens perceive these species as invaders and conflicts are increasing. It is time to celebrate these hard-earned successes and lift baselines for recovering species.

Lifting baselines

About a generation ago, Daniel Pauly posited the idea of ‘shifting baselines’ to describe how cohorts of fisheries biologists perceive the abundance of fish stocks at the beginning of their careers as an ecological baseline. Future changes are then judged against this perceived baseline [1]. Most examples of shifting baselines have come from fisheries, with the all-too-familiar downward trend in biomass and catches: recent estimates suggest that global predatory fish populations have declined by two-thirds in the past century [2].

Yet, other generational shifts have occurred in the last few decades, with species returning to areas where they were once long absent. In many cases, the reduction or elimination of commercial hunting played a critical role. In the 1970s and 1980s, landmark legislation and international agreements were passed, including the Convention on International Trade in Endangered Species (CITES) and the US Endangered Species Act (ESA). Protection from commercial hunting and later bans on dichlorodiphenyltrichloroethane (DDT) led to the recovery of populations of seabirds such as brown pelicans. Protective legislation and supportive public opinion have helped large carnivores recover in Europe [3]. A moratorium on hunting passed by the International Whaling Commission and national legislation such as the US Marine Mammal Protection Act have aided the recovery of whales and seals and prompted their return to areas from which they have long been absent.

In this paper, we propose the concept of lifting baselines, a subset of the shifting baseline syndrome that describes such success stories. We focus on marine mammal recovery because there have been several high-profile recoveries and articles examining their return, although some of

these success stories have also been wrought with conflict. An analysis of trends for 92 marine mammal populations showed that 42% are increasing and only 10% are decreasing, with the remainder showing no change (which could be an indication of recovery) or no discernible trend [4] (see also Box 1 and the supplementary material online). Among the successes are many pinnipeds and several cetaceans. All great whale species with published trends in the International Union for Conservation of Nature (IUCN) Red List are increasing or stable (although trends for half of the 14 species are unknown). Consider the humpback whale, star of the thriving whale-watching industry. In 1968 there were fewer than 300 humpbacks off Western Australia; after whales were protected, this population grew to 26 000 individuals, at an annual rate of about 13% [5] (see also the supplementary material online). A similar story can be found with the northern elephant seal. In the nineteenth century, the elephant seal was hunted so intensively in the North Pacific that it was presumed extinct by the 1880s – perhaps as few as 20 individuals survived. Mexico and the USA protected the species in the 1920s and it has since recovered to more than 200 000 seals [6] (see also the supplementary material online). With a population size approaching carrying capacity, there might be more elephant seals now than at any time since humans first encountered them (Figure 1) and sighting elephant seals is a customary part of life for residents of the US Pacific coast. Yet in the early careers of many older biologists, raised at a time of marine mammal deficit, such an encounter would have been a surprising, memorable event – the reestablishment of species sets new reference points for each generation, the consequence of conservation efforts and shifting resource needs.

The recovery of marine predators has not been welcomed uniformly. Many coastal communities and maritime industries have developed while marine mammals were sparse and dispersed, with the implicit assumption that they would remain so. In these cases the perception of a surplus model of marine predators emerges, where they seem overabundant regardless of pre-exploitation numbers. In eastern Canada, for example, gray seal populations have increased by 1410% since 1977 [7]. Consequently, a Canadian Senate Committee proposed to cull 70 000 seals to increase yields of groundfish, although it produced no evidence linking them to the stocks’ collapse. Gray seals are also recovering rapidly in US waters and conflicting with human activities (Box 2).

There is a need to counter the shifting baseline syndrome through a process of lifting baselines, where the

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Box 1. How common is recovery?

Of course, the phenomenon we highlight here is by no means universal. The sixth mass extinction on our planet is real and by most measures the state of biodiversity is deteriorating [13]. Areas such as Southeast Asia are experiencing marked increases in overall extinction risk as a result of agricultural conversion, timber harvest, and unsustainable hunting [14]. Perhaps of equal concern, we simply do not have the data for many species to assess whether they are threatened or whether their current populations are in decline.

In the oceans, many species of large vertebrates show little or no sign of recovery and remain in a precarious conservation status. For example, of the 87 cetacean species assessed as part of the IUCN Red List, 15 are considered to be of conservation concern (critically endangered, endangered, or vulnerable) and only 22 are of least concern. Most (45) cetacean species remain to be evaluated because of data limitations. Of the 14 species of great whale – many of which had been under intense commercial pressure in past centuries – 36% are increasing, 14% stable, and 50% unknown. The impacts of the whaling moratorium and other management efforts are clear. Pinnipeds, with their faster life histories, fare slightly better than cetaceans, with only 13 species or subspecies of conservation concern compared with 26 taxa of least concern, including the northern elephant seal and gray seal highlighted here. Some baselines will never change: three species – the Japanese sea lion (*Zalophus japonicus*), Caribbean monk seal (*Monachus tropicalis*), and baiji (*Lipotes vexillifer*) – are now extinct.

successful recovery of depleted species is verified, celebrated, and understood in an ecological and historical context. Salient events, such as reports of first encounters with abundant animals and later actions to avoid extinction, could help incorporate an understanding of historical ecology into the collective memory.

Strategic recommendations

There is little guidance for communities seeking to coexist with formerly depleted species as they recover or return to areas from which they have been extirpated and where adaptations for coexistence have been lost. Here we propose four strategic recommendations to lift baselines, develop supportive public opinion, and create an accepting sociopolitical climate around conservation successes.

First, when protection works, conservation scientists and nongovernmental organizations should celebrate these success stories, actively engaging the public in recording a species' return to former ranges and framing the recovery trajectory in light of the historical abundance, ecosystem health, and natural capital. The state of Nebraska, for example, encourages observers to report whooping crane sightings as the birds migrate through the state. Although still endangered, crane populations have increased 15-fold since the 1960s (see the supplementary material online). Such public engagement can help foster a sense of responsibility for recovery. The use of historical ecology to identify meaningful baselines and increase awareness of the potential abundance of recovering species is essential. Without such understanding, recovered populations could be perceived as invasive species, nuisances, or pests – and calls for culls will grow.

By estimating the benefits of abundant wildlife populations, particularly at local scales, support for their return will rise. Marine mammals were once valued exclusively as a source of commercial goods to be removed from the ocean; they are now valued for the services they provide. Whale watching is a global industry worth approximately

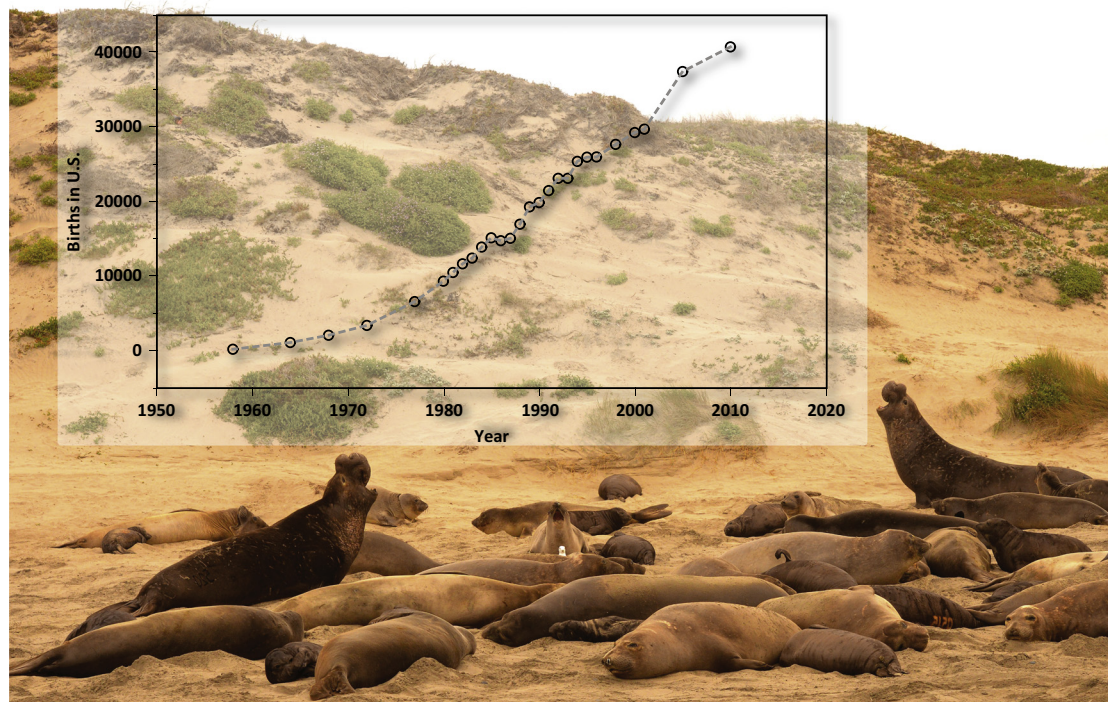


Figure 1. Northern elephant seal rookery on Año Nuevo Island, CA. There are probably more individual seals in this photograph than there were in the North Pacific Ocean before conservation efforts were enacted by the USA and Mexico. Overlay: Rise in number of births of elephant seals since 1960 [6]. Photo courtesy of Ari Friedlaender, taken under permit by NOAA.

Box 2. Gray seal recovery in the USA

Gray seals are recovering from depletion in coastal areas across the temperate and sub-Arctic North Atlantic. Historical evidence from Native American middens and the logs of early European explorers reveals that they previously formed large colonies along the east coast of North America from Labrador south to Cape Hatteras. During the 19th and 20th centuries, gray seals in this region were depleted through a combination of subsistence hunting and government-sponsored bounty programs. The passing of the US Marine Mammal Protection Act in 1972 provided protection in US waters, and in the following decades gray seals grew in abundance and reoccupied substantial portions of their original range (Figure 1). In the Cape Cod, MA region, gray seals were rarely sighted in the 1980s but are now a common occupant on ocean-facing beaches. While the current abundance of gray seals in US waters is unknown, the most recent beach counts revealed that at least 15 756 gray seals inhabit the Cape Cod region and the number of pups born at one colony has grown exponentially from six in 1990 to 2095 in 2008 [15]. Some have embraced the recovery of gray seals in southern New England through seal-watching ventures, but acceptance is far from universal. Indeed, some people who have grown up in coastal communities of Cape Cod view the gray seal as an invasive species and the seals are increasingly blamed for declining fishery yields, changing water quality, and attracting greater numbers of white sharks into coastal waters. One resident, quoted in a news story about the increasing gray seal population, provided an extreme perspective on their recovery: 'Their benefit to humanity is just about on the level with mosquitoes and houseflies.' Some have gone further than expressing concern about the return of gray seals to southern New England: in 2011, six gray seals were illegally shot and killed.

There is an urgent need to confront conflicts between people and gray seals. The lack of data on the demography of these seals and the roles they play in the coastal ecosystem has generated a seascape of fear, where seals are seen as unnatural threats to coastal livelihoods.

US\$2 billion per year; cetaceans also provide ecological benefits, such as enhancing primary productivity in areas where they feed, supporting deep-sea biodiversity, and sequestering carbon [8]. An ecosystem perspective is helpful: whereas the return of individual species can be flash-points, healthy and resilient ecosystems rarely attract such resentment. A kelp forest is seen as an asset to fishers and conservationists alike, even if the sea otter that helps maintain it is not.

Second, we should down list and delist species that no longer require special protective measures, rewarding efforts that reverse a species' decline. Gray whales were removed from the US list of endangered species in 1994 and continue to remain stable. And most (10 of 14) humpback whale populations could soon join gray whales on this list of conservation success stories. For humpbacks, as with other recovering species, quantitative guidance is required to determine what level of risk should result in delisting. Celebrating success and freeing time and resources for other animals and plants is essential in fighting the moral wrong of extinction. Recoveries should not be reasons for complacency, but rather should be seen as calls to action: ongoing declines elsewhere can also be reversed.

Third, conflicts resulting from the range expansion and trophic interactions of recovering species must be anticipated and proactively managed. Habitat suitability models can predict areas of expansion and identify conflicts before they occur. As ranges expand, we should monitor ecological changes that result from a species' return and engage

A greater scientific understanding of the abundance of these seals and their ecology – past and present – is needed. This new knowledge, integrated into a thoughtful communications campaign that actively educates the public about their recovery and the opportunities it creates, is required to move past fear into understanding and coexistence.

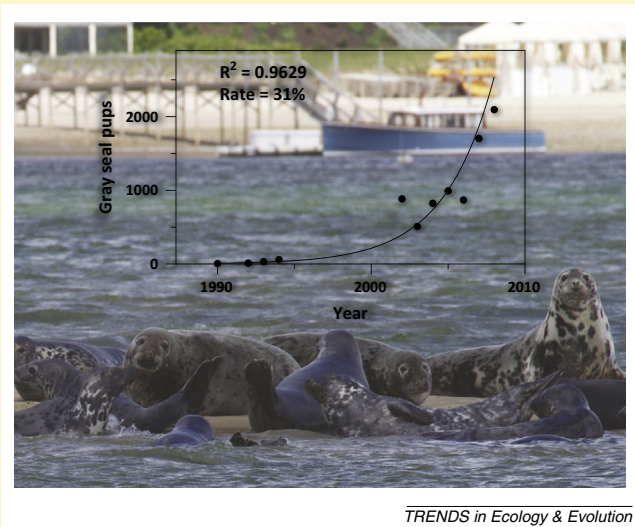


Figure 1. Gray seals hauled out near Chatham Harbor, MA in the summer of 2014. Superimposed on this image is a graph of single-day pup counts at Muskeget Shoals from 1990 to 2008, illustrating the exponential increase of gray seal pups born at that location. Data from the National Marine Fisheries Service (NMFS) [15]. Photo by D.W. Johnston, taken under permit by NOAA.

stakeholders as part of the recovery strategy. Such activities help to anticipate arguments that blame animals for the failures of resource management. As a recovered species assumes its ecological role, it will influence other species – rare and common alike – and affect food webs and trophic cascades. Investigations into the functional relations between interacting species of concern, such as sea otters and their rare northern abalone prey, will help develop realistic recovery targets and avoid setting unachievable management goals [9]. To lift baselines, trained science communicators, facilitators, conflict managers, and negotiators must help resolve conflicts.

Finally, the true costs and benefits of removing so-called nuisance animals, whether through translocation, aversive conditioning, or lethal means, must be established. Predators have long been persecuted for killing livestock. Conflicts with seals attending ocean net-pen aquaculture sites are likely to remain a problem, especially given depleted wild fish stocks. In Irish waters, the permitted or illegal killing or scaring of seals and other predators continues in many areas where conflicts occur, yet there is little follow-up after the removal of such nuisance individuals and cost-benefit analyses are rarely performed for lethal controls [10]. The level of depredation and associated cost to fishing sectors must be quantified and should include both ecological and social measures. If controls are not cost-effective, a less destructive approach is needed.

These recommendations should be adopted while initial conservation measures are being put in place. Clear recovery goals can help species, from wolves to whales, move off

the endangered list, and true estimates of costs and benefits can provide transformative views of wildlife: from scapegoat to valued neighbor. Adopting these measures is no trivial task. It will require interdisciplinary work involving social scientists and economists to help estimate and address the benefits and costs of recovery. Artists, journalists, and writers are essential: stories capture public attention – and what better storyline than the recovery of an endangered species? Examples of restoration in other systems that have led to general acceptance provide hope. By the 1960s American alligators were hunted to near extinction and rarely seen in the wild. Today they number in the millions and are a common sight on golf courses and in urban canals. Public opinion in Florida is generally favorable toward this large carnivore [11]. Approximately 700 grizzly bears inhabit the Greater Yellowstone area, an increase of more than 500% since they were listed under the ESA in 1975, and the US Fish and Wildlife Service is expected to propose removing the bear from the endangered species list. A survey in Wyoming indicated that 61% of residents support grizzly bear recovery in the area if the efforts are coupled with education and management to reduce human–bear conflicts [12].

Although we have focused here on conservation successes, there is no doubt that many wild species and ecosystems remain threatened (Box 1). We live in an age of extinction [13], with more species moving toward higher levels of threat than are moving toward recovery [see the IUCN Red List Summary Statistics (<http://www.iucnredlist.org/about/summary-statistics>)]. Yet we have reversed this trend with some species and should celebrate our conservation efforts and lift public baselines for native fauna and flora. Clearly there will be difficult decisions to be made along with the celebrations, but these are choices of abundance rather than scarcity – rare and welcome opportunities for conservation biologists, resource managers, and society.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.tree.2015.04.003>.

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Supplementary Material

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Conservation efforts in freshwater, marine, and terrestrial systems have demonstrated the potential for recovery of species and ecosystems. In the oceans, 10–50% of depleted populations and ecosystems show evidence of recovery, although only a few have returned to their former abundance [S1]. In the United States, the American alligator, bald eagle, brown pelican, gray whale, and more than 20 other species have recovered and been removed from the federal list of Endangered and Threatened Wildlife (see: http://ecos.fws.gov/tess_public/reports/delisting-report). Ten of 14 populations of humpback whales and Hawaiian green turtles are also being considered for delisting. Below, we provide a detailed summary of several population recoveries. Although this list is not comprehensive, it highlights the results of several decades of conservation actions that include harvest management and prohibition, habitat protection, invasive species control, species reintroduction, and national and international legislation.

Marine Mammals

North Pacific Humpback Whale (Megaptera novaeangliae)

After being reduced by commercial exploitation to fewer than 1,500 individuals in the 1970s, North Pacific humpbacks have increased by about 6% per year and now number approximately 21,000 whales [S2]. This increase is approximately 14 fold in less than 50 years.

Australian Humpback Whale (Megaptera novaeangliae)

Australia has two populations of humpback whales, one that migrates along the west coast of the continent (known as breeding stock D to the International Whaling Commission) and one on the east (stock E1). Both populations were greatly depleted by commercial whaling. In 1968, the western stock, which has one of the longest records of study in the Southern Hemisphere, was estimated to number 268 animals [S3]. The eastern stock was estimated to have 500 whales in 1962 [S4]. Both have grown rapidly since the cessation of commercial whaling, increasing at or above 10% annually in recent years [S5]. The western population was estimated to number 26,100 whales in 2008 [S5], and the eastern population was estimated at 14,522 whales in 2010 [S6]. A recent study by Clapham et al. suggested that part of this high rate of increase could be because of temporary immigration and social aggregation from nearby groups in Fiji and New Zealand, which have not seen increases [S7].

Eastern North Pacific Gray Whale (Eschrichtius robustus)

Gray whale populations in the eastern North Pacific have increased from population lows in the early 1970s of an estimated 11,000 to a current population size of 19,000 [S8]. In a separate formal stock assessment, Punt and Wade estimated that the population had recovered from past overexploitation and was currently at 85% of carrying capacity [S9].

Western North Atlantic Gray Seal (Halichoerus grypus)

Pup production in eastern Canada was estimated to be 76,300 (95% CI=60,000-105,000) in 2012, with a total population size of 331,000 seals (95% CI=262,000-458,000) [S10]. The estimate does not include gray seals residing in U.S. waters and is, therefore, negatively biased. Pup production at the largest colony on Sable Island increased exponentially at a rate of 12.8% per year between 1970 and 1997 [S11], but has declined to about 4% per year between 2007 and 2010, and to 2.8% from 2010 to 2012 as the population approaches carrying capacity [S12].

Northern Elephant Seal (Mirounga angustirostris)

Northern elephant seals were reduced to as few as 20 individuals through overexploitation in the late nineteenth century [S13]. Since 1988, the U.S. population has been growing at an average annual rate of 3.8% [S14]. The formal NOAA stock assessment indicates that the population reached its Maximum Net Productivity Level (MNPL) of 19,000 pups in 1992 and is now approaching carrying capacity of 38,200 pups per year [S15].

Sea Otter (Enhydra lutris)

Sea otter populations once numbered about 150,000 to 300,000, occurring from northern Japan to the Baja Peninsula of Mexico [S16]. After more than 100 years of commercial exploitation, the North Pacific sea otter was reduced to about 1000 individuals in 13 remnant colonies during the nineteenth century [S17]. Protections from commercial hunting and reintroduction efforts that extended from Southeast Alaska to Oregon have resulted in substantial range expansion of this ecosystem engineer. Population estimates made between 2004 and 2007 give a worldwide total of approximately 106,822 sea otters [S16].

Marine Turtles

Green Sea Turtle (Chelonia mydas)

Green turtle nesting populations have been the subject of extensive long-term studies for more than 25 years. Six of the world's major green turtle nesting populations have been increasing at rates of 4 to 14% per annum over this time, following protection from exploitation of eggs and turtles [S18]. These relatively simple conservation strategies have led to population recoveries—the six major stocks likely comprise tens of millions of green turtles, rescuing the green turtle from global extinction. In 2015, the U.S Fish and Wildlife Service proposed to change the status of green turtles in Florida and the Pacific Coast of Mexico from endangered to threatened. Some stocks, however, remain seriously depleted, and diseases such as fibropapillomatosis are a major problem in areas such as the nearshore reefs of Florida [S18, S19].

Terrestrial Carnivores

Gray Wolf (Canis lupus)

Gray wolf populations have increased in the past 40 years in the United States and Europe [S20]. In the western Great Lakes, wolves had been extirpated in Wisconsin and Michigan and reduced to 500 to 1000 individuals when protections were established in 1973. By 2010, there were 2921 in Minnesota, 782 in Wisconsin, and 687 in Michigan, an estimated 5-fold increase in less than 40 years [S21]. After being extirpated from much of the Northern Rockies in the United States, 66 wolves were reintroduced to Yellowstone National Park and Idaho in 1995 and 1996. The total population of gray wolves in the region had grown to 1,691 individuals by 2013 [S22].

Black-footed Ferret (Mustela nigripes)

The black-footed ferret declined during the twentieth century in North America and was considered possibly extinct, until a remnant population of about 100 animals was found in 1981. After canine distemper and plague decimated this population, the remaining 18 individuals were removed from the wild for captive breeding. Since 1991, more than 2,900 ferrets have been released in 19 reintroduction projects across 8 States, Canada, and Mexico [S23]. Ferrets have been successfully reintroduced to at least 4 of these areas, which have large numbers of prairie dogs, their primary prey, and the species continues to expand its range [S24]. In the case of the ferret, recovery planning to set baselines did not depend solely on historical ranges, but rather emphasized the identification of reintroduction sites based on current habitat assessments [S25].

European Carnivores

In 2014, Chapron and colleagues compiled data about the current and past occurrence and abundance of four large carnivores in Europe [S20]. Their supplementary material provides detailed evidence of the range expansion and population increases of European brown bears (*Ursus arctos*), lynx (*Lynx lynx*), gray wolves (*Canis lupus*), and wolverines (*Gulo gulo*). Here we provide some highlights.

There are approximately 17,000 brown bears in Europe. In many countries, populations have increased more than 5 fold since times of lowest abundance between 1950 and 1970. Brown bear populations in Finland have increased more than 10 times since that time. The brown bear range in the Alps has increased by a factor of 20 and now totals 12,200 km².

Lynx populations total about 9,000 in Europe. The cats have been reintroduced to many areas where they had been eradicated, and populations have increased more than 5 fold in Sweden, Estonia, and the Czech Republic since the time of lowest abundance between the 1950s and 1970s. Their total range is now 1,446,200 km², a more than 3-fold increase.

Wolf populations total about 12,000 in Europe. Populations in Poland have expanded 28 fold since the time of lowest abundance, with 67 to 77 wolf packs now established in the country. Wolves now range over 1,280,100 km² in Europe, tripling their former extent.

Wolverine populations have increased more than 5 fold in Sweden and Finland and have doubled across Europe since the 1950s to 1970s. Their total range, 355,300 km², has tripled, though it is the smallest of the European species in the study.

Island Fox (Urocyon littoralis)

In the 1990s, populations of the island fox, found exclusively on the Channel Islands of California, declined rapidly. At the end of the decrease, two islands had only 15 wild foxes, and the remaining islands had only 10 to 20% of historic levels [S26]. The U.S. National Park Service convened a group of experts and stakeholders, the Island Fox Conservation Working Group, that proposed recovery efforts that included the translocation of golden eagles, island fox captive breeding and reintroduction, disease mitigation via vaccination, the removal of nonnative ungulates and the reintroduction of bald eagles [S27]. Island fox numbers have been steadily increasing as a result of these efforts, reaching a total population of approximately 5,500 and an adult population of more than 4,000 in 2011 [S27]. The island fox was moved from critically endangered to near threatened in 2013 and the US Fish and Wildlife Service is considering removing the fox from the endangered species list because of the recovery.

Birds

Peregrine Falcon (Falco peregrinus)

In North America, the peregrine falcon was listed as endangered in 1969, under legislation that preceded the U.S. Endangered Species Act of 1973. At the time, the species had been eliminated from the eastern and midwestern United States, persisted in low numbers in the western U.S. and Mexico, and was reduced to about 70% of historical numbers in Alaska and Canada [S28]. After a ban on the use of DDT and captive breeding, rearing, and release, populations were reintroduced across the U.S. and Canada.

When the species was delisted in 1999, there were more than 2,000 breeding pairs in the U.S. and 400 pairs in Canada [S28]. Populations have continued to increase in North America since the species was delisted. Reintroduction efforts continue in Europe, and the global population, estimated at approximately 1,200,000, is considered stable [S29].

Bald Eagle (Haliaeetus leucocephalus)

The bald eagle was listed as endangered in 1967, under legislation that preceded the Endangered Species Act. According to the US Fish and Wildlife Service, which conducts annual surveys, there were 487 breeding pairs in the continental US in 1963. As a result of pesticide controls, habitat protection, and reintroduction efforts, 9,789 breeding pairs were recorded in 2006 [S30]. The species was delisted in 2007, but remains protected by the Migratory Bird Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940.

Whooping Crane (Grus americana)

There were fewer than 50 whooping cranes in North America prior to 1968, with an all-time low of 21 in 1954 [S31]. After habitat protections were put into place and wild flocks were introduced, populations have grown to 384 in the wild (247 in the original Aransas/Wood Buffalo flock and the rest in two experimental flocks). There are 152 cranes in captivity as of October 2009 [see www.operationmigration.org].

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